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Secondary corpuscule detector and its arrangement in a corpuscular beam apparatus

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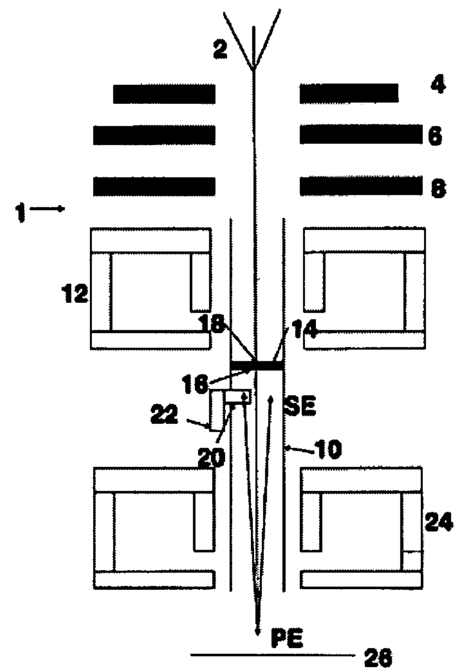
Abstract of **EP0917178**

Detector has a scintillation layer (16) for producing photons when hit by the secondary corpuscles. The scintillation layer and its substrate (14) have a through hole (18) for the primary beam. A detector device (20,22) senses and evaluates the photons. The substrate is very thin around the primary beam hole, which is very narrow. A corpuscular radiation device is also claimed.



Translation of EP 0 917 178

Result Page

[0001] The invention concerns a detector for secondary corpuscles with a scintillation layer, for the production from photons with the impact of the secondary corpuscles, and a carrier for the scintillation layer, which are provided with a passage for the primary jet, and a detection mechanism to taking up, feeling and evaluating the photons.

[0002] Such a detector is well-known from the EP 0,274,622 (B1).

[0003] Such detectors become in particular in Korpuskularstrahlgeräten, in those corpuscles (mostly electrons, in addition, protons, ions and other electrically charged particles) using a particle optics of an appropriate source (z. B. a cathode) on a goal to be steered, assigned.

[0004] With a certain class of Korpuskularstrahlgeräten those become, hitting from on a sample (then: Primary) corpuscles released secondary corpuscles felt (detected) and evaluated for the acquisition of information about the sample. An example is the scanning electron microscope, with which as finely as possible (within the nanometer range) by electron optics focused an electron beam is led by an additional deflecting system across the sample. In the following usually of electrons instead of general of corpuscles one speaks. The invention is not limited however to electrons.

[0005] The detector is arranged and the secondary electrons by a deflection field in the sample chamber on the detector is steered laterally the sample with some devices. This requires a minimum distance between the objective of electron optics and the sample, which worsens the dissolution. Furthermore the deflection field can worsen the dissolution of the primary jet.

[0006] It is already well-known to arrange a detector above the objective laterally. The Sekundärlektronen in the electron-optical column is diverted by a vienna filter (overlay of a magnetic and an electrostatic field) laterally on the detector. The combined electrostatic-magnetic field can be dimensioned in such a way that the initiating electrons are not affected. However the realization is very complex and a very exact tuning of the system is necessary, in order to avoid an influence of the primary jet.

[0007] With a detector of the initially indicated kind the secondary electrons are steered photons radiating scintillation layer, which is applied on also, from the side of the secondary electrons turned away an arranged detection mechanism for the photons from the scintillation layer, serving as carriers for the scintillation layer, on a very thin. The initially indicated detector is brought above the objective into the path of rays of the primary jet. This requires however a central cylindrical opening for the passage of the primary jet by the detector to the sample. Unfavorable it is to the fact in particular that the central cylindrical opening relatively largely (diameters approx. 2 mm) to be selected must, so that a contamination of the inner walls of the developing cylinder, which can lead to disturbing loadings or fading out of the primary jet, can be avoided.

[0008] (For symmetry reasons usually cylindrical) the range around the primary jet axle, outside of whose components of the detector must be held (z. B. with the initially indicated detector with scintillator or also with a Multichannelplatte), ?fault area? one calls here.

[0009] The necessary large opening in the fault area leads now again to the fact that the straight Sekundärlektronen, and thus, flying in the environment of the Z-axis of the primary jet, a large part of the secondary electrons, which meets cylindrical passage and is lost with it for the evaluation.

[0010] Task of the invention is it to create a detector of the indicated kind with that the secondary electrons with high yield, D. h. as completely as possible, and without impairment of the primary jet to be detected can.

[0011] This according to invention reached by it that the carrier for the scintillation layer is trained as very thin mother board at least in a cylindrical fault area around the passage, the scintillation layer as very thin layer trained is, the passage for the primary jet as very close opening is trained, and the entrance range of the detection mechanism for the photons also from the circular range of the scintillation layer, is radially outside of the fault area for the primary jet (PE), defined by the fault area, arranged.

[0012] The relationship from diameter to height of the passage amounts to preferentially approx. 1:3, particularly prefers at least 1:3.

[0013] The thickness of the mother board is downward only through requirement certain mechanical firmness and management limited and thus that the scintillation layer must be applied.

[0014] Because the scintillation layer basic carriers project into the fault area are left, will it possible to seize also the secondary electrons for the scintillation, ohnear to the primary jet. Since the carrier is there extremely thinly trained however according to invention (at least), the walls of the remaining passage cylinder for the primary jet are so small the fact that, as turned out they do not affect the primary jet negatively despite the larger proximity.

[0015] Because the entrance range of the detection mechanism for the photons coming from the additional scintillation surface lies outside of the fault area, is to be expected also from there no impairment of the primary jet.

[0016] If necessary additionally a new element does not need to be brought into the particle optics, on the contrary the layer can on existing and/or. anyway necessary screens for the primary jet to be applied.

[0017] Preferentially the entrance range is by, rising up into the cylinder defined by the radius of the scintillation layer around the primary jet, light conductor in an educated manner.

[0018] Such a light conductor, which is arranged preferentially in a distance from several millimeters to the primary jet, in such a manner that the primary jet is not affected, registers, D. h. takes up and passes, an appropriate part on of the photons released by the secondary electrons. On the one hand it shields only one part de Sekundärelektronen, on the other hand one the fact that only one part of the released photons is registered, leads not to a degradation of the signal-noise ratio, since a secondary electron produces typically 200-500 photons.

[0019] Preferentially the light conductor is trained as a light guidance staff (20).

[0020] But the advantages evenly specified apply in particular.

[0021] Preferred the mother board consists of molybdenum or a molybdenum alloy or also a platinum. These materials for this particularly worked.

[0022] Preferentially the carrier for photons from the scintillation layer is permeable and is at least the photon entrance range of the detection mechanism in the semi-infinite space of the carrier arranged.

[0023] With an accordingly thin scintillation layer the photons released by the secondary electrons pass through also to the rear the layer and can pass through then the mother board and occur an accordingly arranged entrance range of a detection mechanism for the photons of the detector. Thus additional liberty is won during the arrangement of the components of the detector.

[0024] Preferred the diameter of the passage for the primary jet lies between 5 and 200 mu m,

[0025] This is implemented could like already above escape, by the small thickness of the mother board with scintillation layer possible and the advantage that the diameter of the opening between two and three orders of magnitude is smaller than with conventional devices, thus the surface, by the secondary electrons unused, without production of photons, around four to six orders of magnitude is smaller.

[0026] Particularly preferentially the diameter of the opening lies between 10 and 50 mu M. This range turned out as optimal for the requirements of simple production with retention of the described advantages.

[0027] Preferred the thickness of the mother board lies in mu the m-range.

[0028] Preferred the thickness of the mother board lies between 1 and 100 mu m, particularly preferentially between 1 and 10 mu M.

[0029] With these thicknesses, and with consideration of the fact that the thickness of the coating carries only few mu for m, the initiating electron jet is practically not impaired.

[0030] Preferentially scintillation layer and mother board integral are trained, z. B. as foil with szintillierenden components.

[0031] The invention concerns also a Korpuskularstrahlgerät with a source for the production of the primary corpuscles in the primary jet, a sample, which primary corpuscles hit under production of secondary corpuscles, and a particle optics, in order to steer the corpuscles of the source on the sample. This is the preferential operational area of a detector with the characteristics described above.

[0032] Such a detector is arranged in the path of rays of the primary jet of the Korpuskularstrahls of the Korpuskularstrahlgerätes. The arrangement takes place naturally in such a way that the axle of the Korpuskularstrahls passes through by the passage.

[0033] Preferentially the detector is arranged in jet direction of the primary corpuscles before the objective of the particle optics.

[0034] This is on the one hand appropriate due to space considerations, and furthermore focuses the objective also secondary corpuscles, z. B. Secondary electrons.

[0035] Preferentially the scintillation layer on an aperture diaphragm for the primary jet is applied. If this fulfills the appropriate requirements, and/or. in the context of the invention-moderate arrangement, is necessary no separate carrier is illustrated in such a way for the scintillation layer, which saves area and which total structure of the Korpuskularstrahlgerätes simplifies.

[0036] In the following the invention is still more near described on the basis a preferential execution form with reference to the attached designs, to which because of your clarity and clarity regarding revealing expressly one refers. Show:

Fig. 1 schematically the Gesamtanordnung of the Korpuskularstrahlgerätes according to invention.

Fig. 2 schematically more in detail the scintillation detector according to invention.

[0037] Altogether with 1 designated Korpuskularstrahlgerät a source, in the available case a sending cathode 2, exhibits electrons which lies on -1 kV.

[0038] Electron optics points a modulator electrode 4, which lies for example on -1,5 kV, a suction electrode 6, to approx. + 3 kV and an anode 8 rests upon.

[0039] The anode 8 lies on approx. + 10 kV.

[0040] The electron beam steps into a pipe 10 (diameters approx. 12 mm) from not-ferrousmagnetic material, which exhibits the potential of the anode 8.

[0041] The condensor lens 12, which bundles the initiating electron jet PE (here only schematically shown, surrounds the upper range of the pipe).

[0042] In the place of an aperture diaphragm the mother board according to invention 14 is, on of them in Fig. 1 side the scintillation layer 16 arranged downward is applied. The carrier 14 has a thickness of 10 mu m, the scintillation layer a thickness of 5 mu M. By both a concentric, aligning opening 18 for the initiating electron jet PE with the diameter of 10 mu m passes through. Below the scintillation layer is the light guidance staff 20, that passes the photons on from the scintillator coating to a photomultiplier 22, where they are further-strengthened and evaluated.

[0043] Arrangement from mother board 14, scintillation coating 16, for which passage 18 for the initiating electron jet and the light conductor staff 20 are appropriate above the objective 24, which focuses the initiating electron jet PE on the sample 26, which is on a potential of 0 V.

[0044] The secondary electrons SE released on the sample 26 occur against the direction of the initiating electrons PE the pipe 10 and thus this surrounding objective 24 and arrive at the scintillation layer 16, where they release photons the meeting the light conductor 20. Because of the small surface of the hole 18 only a infinitesimal small part of the secondary electrons through this opening to be lost.

[0045] Fig. 2 shows in Fig. 1 partial arrangement according to invention in the context of the Gesamtanordnung shown more in detail.

[0046] The initiating electron jet arranged schematically with PE runs in the pipe 10 already mentioned and steps, depending upon its thickness here, faded out or unhindered by the close, low passage opening 18. The mother board 14 with the scintillator coating 16 is at the same time an aperture diaphragm in the electron-optical path of rays.

[0047] By the secondary electrons SE released photons 30 (exemplary courses are marked with 32, 34 and 36) meet the light conductor 20 and from this to the photomultiplier 22 are at least partly led. The light conductor 20 serves also for it, the voltage-sensitive photomultiplier of the pipe 10 which is on the potential of the anode 8 and/or. the mother board with scintillator coating, 14, likewise which is on this potential, and/or. 16 to remove-hold.

Claims:

1. Detector (11) for secondary corpuscles also

a scintillation layer (16), to the production of photons (30; 32, 34, 36) with the impact of the secondary corpuscles (SE), and
a carrier (14) for the scintillation layer (16),
(14; 16) with a passage (18) for the primary jet (PE) are provided, and
a detection mechanism (20, 22) to taking up, feeling and evaluating the photons (30; 32, 34, 36),
by the fact characterized that
at least the carrier for the scintillation layer (16) in a cylindrical fault area around the passage (18) as very thin mother board (14) is trained,
the passage for the primary jet (PE) as very close opening (18) is trained, and
the entrance range of the detection mechanism (10, 22), for which photons also from the circular range of the scintillation layer (14), defined by the fault area, is radially outside of the fault area for the primary jet (PE) arranged.

2. Detector according to requirement 1, by the fact characterized that

the relationship from diameter to height of the passage (18) approx. 1:3, preferentially at least 1:3, amounts to.

3. Detector according to requirement 1 or 2, by the fact characterized that

the entrance range by, into the radius of the scintillation layer cylinders defined rising up, light conductor (20) around the primary jet are formed.

4. Detector according to requirement 3, by the fact characterized that

the light conductor as a light guidance staff (20) is trained.

5. Detector after one of the requirements 1 to 4, by the fact characterized that

the mother board (14) of molybdenum, a molybdenum alloy, or platinum consists.

6. Detector after one of the requirements 1 to 4, by the fact characterized that

the carrier (14) for photons from the scintillation layer (16) is permeable and at least the photon entrance range of the detection mechanism (20, 22) in the semi-infinite space of the carrier (14) is arranged.

7. Detector after one of the requirements 1 to 6, by the fact characterized that

the diameter of the passage (18) for the primary jet between 5 and 200 mu m lies.

8. Detector according to requirement 7, by the fact characterized that

the diameter of the opening (18) between 10 and 50 mu m lies.

9. Detector after one of the requirements 1 to 8, by the fact characterized that

the thickness of the mother board (14) in mu the m-range lies.

10. Detector according to requirement 9, by the fact characterized that

the thickness of the mother board (14) between 1 and 100 mu m, particularly preferentially between 1 and 10 mu m lies.

11. Detector after one of the preceding requirements, by the fact characterized that scintillation layer and mother board integral are trained.

12. Korpuskularstrahlgerät (1) also

a source (2) to the production of the primary corpuscles in the primary jet (PE),
a sample (26), on which primary corpuscles under production of secondary corpuscles (SE) hit, and
a particle optics (4; 6; 8; 10; 12; 14, 18, 24), in order to steer the corpuscles of the source (2) on the sample (26), marked through
the arrangement of a detector after one of the requirements 1 to 11 in the path of rays of the primary jet (PE).

13. Korspuskularstrahlgerät according to requirement 12, by the fact characterized that

the detector (11) in jet direction of the primary corpuscles (PE) before the objective (24) of the particle optics (4; 6; 8; 10; 12; 14, 18; 24) is arranged.

14. Korpuskularstrahlgerät after one of the requirements 12 or 13,
by the fact characterized that

the scintillation layer (16) on an aperture diaphragm (14) for the primary jet (PE) is applied.